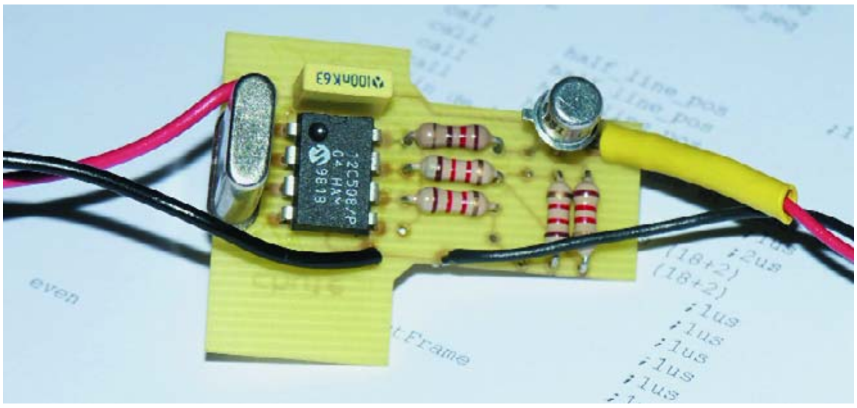
Mini Test Chart Generator

A video test chart for less than a tenner

Design by F. Simonnot

Recognise this? You have to adjust a television or monitor but do not have access to the required tools… This small test chart generator for less than a tenner is then just the bee's knees.



The circuit described here is actually just a standard video signal generator that can be used to synchronise a television or monitor, provided that the equipment being tested is fitted with a composite video signal (CVBS) input. All the timing and corresponding signal levels are generated by a PIC12C508 microcontroller.

This circuit also has a second function. Many video recorders can record stereo sound. It is interesting to exploit this property to make a good quality recording from a radio broadcast, potentially using the recorder's built-in timer. Unfortunately, modern video recorders switch to a background colour when they do not sense a proper video signal at their input. This prevents noise from being recorded, but at the same time the audio signal is also ignored!

Only a small amount of electronics is required to generate a signal that fools a video recorder into thinking that a nice and stable video signal is present at its input.

Finally, we can use the circuit as a simple and reliable stand-alone tester when tracking down video problems.

The schematic

Is it really that easy to generate a video signal with a PIC12C508? As shown by **Figure 1**, a video raster line lasts 64 µs. The start of the line is formed by a sync pulse of about 5 µs duration, followed by a horizontal level of also 5 µs, then follows the actual video signal and finally finishes with a constant level of about 2 µs (this circuit does not generate a sync burst). A small calculation shows us that the length of the 'visible' line is:

64 – 5 – 5 – 2 = 52 µs

Although the PIC12C508 can't be accused of being a speed devil, its capabilities (1 instruction per µs at a clock of 4 MHz) are more than sufficient to do what is expected of it. In addition, because if its RISC-architecture (Reduced Instruction Set Computer) it is eminently suitable for synchronous applications.

The number of necessary signal levels is 3: the level for the sync pulse, the level for black and the level for white. The relative amplitudes between black and black/white are 33 and 66% at 1 V and 75 Ω.

Since the PIC12C508 does not have an on-board D/A converter, we will have to make a kind of DAC ourselves with the aid of a few resistors. By connecting resistors with a value of 1k2 to two outputs of the PIC12C508, we get an output voltage V_{out} of 1/3 V_{CC} (2MSB+LSB), where the MSB is GP0 and the LSB is GP1. When using a 4.5-V battery this generates the following signals: 0 V for the sync pulse, 1.5 V for black, 3 V for grey and 4.5 V for white — values that correspond exactly to the PAL TV standard, which defines the sync pulse as 1/3 of the total amplitude of the signal, and 66% for white.

Transistor T1, connected as an emitter follower, lowers the impedance of the video signal at the output

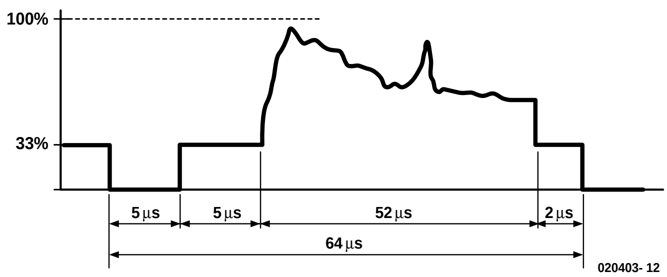


Figure 1. The constituent parts of one raster line of a video signal.

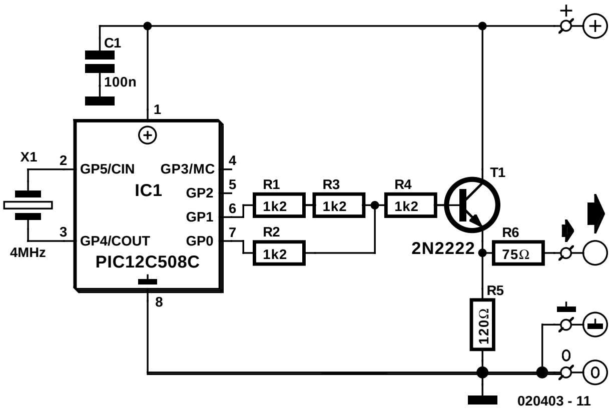


Figure 2. The electronics for the circuit does not amount to much.

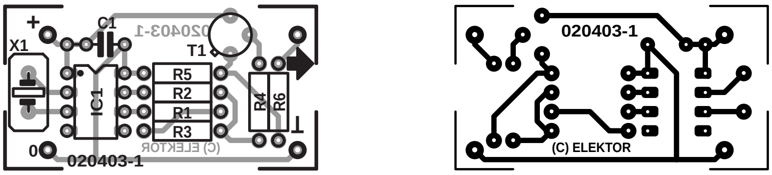


Figure 3. Layout and component overlay for the printed circuit board for the mini test chart generator.

COMPONENTS LIST

Resistors:
R1-R4 = 1kΩ2
R5 = 120Ω
R6 = 75Ω

Capacitors:
C1 = 100nF

Semiconductors:
T1 = 2N2222
IC1 = PIC12C508C (Microchip)

Miscellaneous:
X1 = 4MHz quartz crystal
Disk, PIC program, order code
020403-11 or Free Download

to almost 75 Ω. Nothing else is required to generate a good quality black and white video signal.

The PCB

A quick glance at the PCB in **Figure 3** shows that there are quite a few differences between our design and the author's design (refer photo at the beginning of this article). The missing bottom resistor is explained by the fact that it is incorporated in the wiring for the output (it is hidden in the small piece of shrink sleeving).

The PCB is not available via Readers Services, but can be ordered from The PCBShop via the *Elektor Electronics* website. Alternatively you can etch a board yourself, based on the printed layout (also available from www.elektor-electronics.co.uk). But the number of parts is so small that it is also very easy to mount them on a small piece of prototyping board and connect them according to the schematic.

The program in the PIC

As already noted, the program in the PIC has to be synchronous, because the core of the PIC12C508 cannot service interrupts (INT). And even if it were capable of doing that, it would not be fast enough: at 4 MHz a PIC carries out one instruction per µs. What performance can we expect from this microcontroller? A video line lasts 52 µs, which corresponds to the time it takes to execute 52 instructions. Because of the structure of the DAC, it is not possible to use the BCF and BSF instructions. We therefore have to use `movlw xx` followed by `movwf GPIO`, so that it takes 2 µs to change from one level to another. The resulting minimum dimension of the 'pixel' to be displayed is therefore $625\times(4/3)\times2/52 = 32$ columns. How did we arrive at this number? The display aspect ratio of 4:3 results in 625 video lines in 830 columns. 830 columns in 52 µs corresponds with 16 columns per µs and therefore 32 columns per 2 µs. The duration of the main loop is exactly the same as the period of the raster frequency, 20 ms.

The author decided to select a checkerboard pattern of alternating black and white fields. This is particularly useful when fault-finding two frequently occurring situations: checking the convergence of a doubtful picture tube and checking the electron guns.

The program consists of several calibrated waiting loops (to make economical use of the available ROM space) and two routines to generate the video lines. One is called 'chess' and the other is called 'inv_chess'. The alternating black and white squares displayed on the screen are generated using macro commands.

Figure 4 shows the flow diagram of the program inside the PIC, the source code of which is available from our website or may be ordered on floppy disk (order code **020403-11**).

Some notes

This circuit takes some liberties compared to the proper video standard. The standard makes a distinction between the even and odd raster lines and the composition of the retrace lines. Here, the same raster lines are being generated all the time, but that should

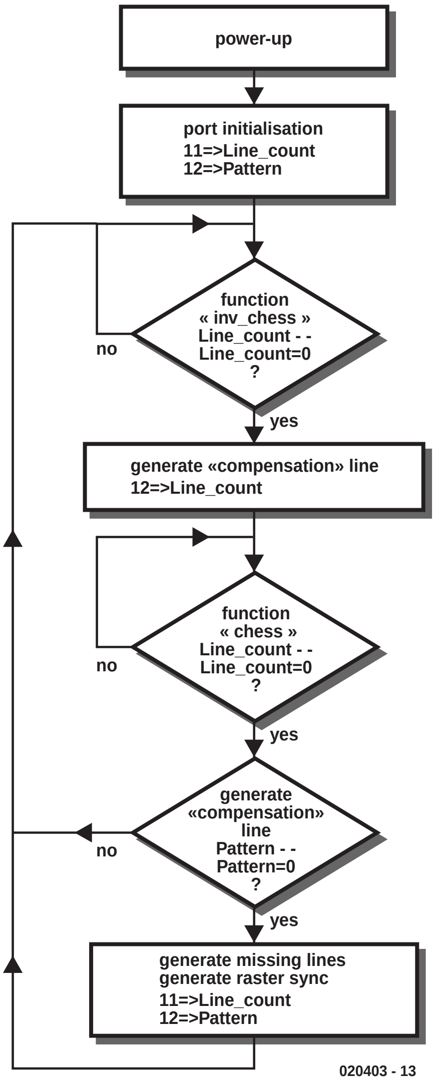


Figure 4. Flowchart for the program inside the PIC.

not cause any problems in practice. Another liberty compared to the standard is the assembly of the line itself: a sync pulse actually lasts 7 µs (instead of 5 µs), a consequence of the structure of the PIC.

For clarity, **Table 1** shows the elements of a picture line.

Table 1. Elements of a picture line

Time (µs)	level	instruction	comment
–1	black	macro TOPLVL	end of previous line
0	sync.		start of sync pulse
1	sync.	return	duration 7 µs
2	sync.		
3	sync.	decsfz line_count	
4	sync.	goto $-2	
5	sync.		
6	sync.	macro BLCKLVL	end of sync pulse
7	black		start of back porch
8	black	call inv_chess	duration 5 µs
9	black		
10	black	nop	
11	black	macro WHITELVL	end of back porch
12	white		start of visible content
13	white	macro BLCKLVL	duration 52 µs
14	black		
15	….		
62	white	macro BLCKLVL	
63	black		front porch
64	black	macro TOPLVL	duration 2 µs
65	sync.		

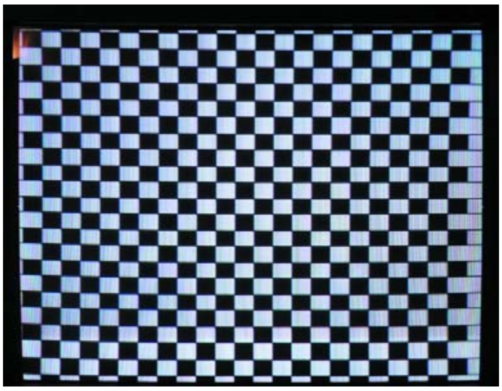


Figure 5. This picture will appear on your TV after connecting the circuit.

The construction

There is not much to say about the mounting of the components. The circuit can be realised whichever way you see fit. Once everything is finished, and the PIC has been programmed, the circuit can be tested. After a 4.5-V battery has been connected to the points next to the crystal (observe the correct polarity) the only other thing remaining is to attach a short length of coaxial cable to the output pins. The other end of the cable is fitted with a cinch connector. Modern televisions and video recorders often have cinch connectors, but if you prefer to use a SCART connector instead, then the video signal is connected to pin 20 and ground to pin 17. If, after you connect the circuit to a TV, the pattern of **Figure 5** appears, then everything is functioning correctly (both the electronics and the program).

Getting acquainted with the PIC12C508

The PIC12C508 from Microchip, which has only 8 pins, is one of the smallest microcontrollers currently on the market. The PIC12C5xx family contains, in addition to the '508, the '509 and '518. The '508 has an EPROM size of 512 words of 12-bit width and a RAM of 25 bytes. The instruction set for this family comprises only 33 instructions. The '509 has a 1024-word EPROM and 41 bytes of RAM. The 'CE518 and 'CE519 are versions with a data-EEPROM of 16 bytes. The members of this semiconductor family carry out every instruction in one processor cycle (that is 1 µs with a crystal frequency of 4 MHz).

A more recent version is the PIC12C508A, and also the 12C509A.

For extensive information about this subject we recommend that you visit the Microchip website: www.microchip.com/1000/pline/picmicro/category/digitctrl/8kbytes/devices/12c508/

(020403-1)

Free Downloads

PIC source code. File number: **020403-11.zip**
PCB layout in PDF format. File number: **020403-1**.zip
www.elektor-electronics.co.uk/dl/ dl.htm,
select month of publication.